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Original citation & hyperlink:
Al-Samarraie, H, Eldenfria, A, Dodoo, JE, Alzahrani, AI & Alalwan, N 2019, 'Packaging design elements and consumers' decision to buy from the Web: A cause and effect decision-making model', Color Research and Application, vol. 44, no. 6, pp. 993-1005.
https://dx.doi.org/10.1002/col.22427

DOI 10.1002/col.22427
ISSN 0361-2317
ESSN 1520-6378

Publisher: Wiley

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Abstract

Recent advances in e-commerce have resulted in significant progress being made towards strategies, requirements, and the development of various mechanisms aimed at influencing consumers' decisions to purchase online. The relationship between different packaging design elements (PDEs) and their effect on consumers' online buying decisions has been less researched, due in part to the lack of statistical power to detect cause and effect relationships between these PDEs. This study examines the feasibility of multiple-criteria decision making (DEMATEL) in order to identify and analyse the causal relationships between the different PDEs that are required to stimulate consumers' decision to buy products online. Consumers' direct, indirect, and interdependent behaviours in relation to PDEs and purchase decisions were studied for this paper. A total of 142 students (89 males and 53 females; aged 22–37 years) participated in this study. The results identified several associations between PDEs. The four most important PDEs found to influence consumers' decision to buy via the internet were graphics, colours, label information, and country of origin respectively. This study provides the necessary insights into the design of product packaging by targeting aspects related to the appearance of the products' characteristics. Correlations between the various PDEs obtained from this study can be used to increase consumers' interactions with products in e-commerce environments.

Keywords: packaging design, information management, consumer decision-making, ergonomics

1. Introduction

In today's internet-enabled world, faster access to goods and services has enabled more efficient pricing and effective matching of buyers and sellers. In a Web-based marketplace environment, many competing factors have been reported to affect consumers' decision-making efforts. For example, communicating the quality of a product in an on-line setting could be very challenging due to the variety of environments in which a product may be used in ways other than that intended by its designer[1]. Recent e-commerce advances have resulted in great improvements in strategies, requirements, and developments of a range of tools that can impact consumers' online purchasing decisions. These include technologies which increase the user-friendliness and convenience of online products, such as virtual mirrors, 360 spin[1], and image interactivity[2]. These technologies can potentially offer consumers a priori simulated experience of a product, as well as being a source of information to aid their purchase decisions on an e-commerce platform[3].

Furthermore, product packaging design elements (PDEs), which are the focus of this study, have been identified in the literature as a powerful marketing cue which may drive individuals' purchasing intentions[4-6]. The relationship between consumer buying behaviour and the packaging design elements of products has been noted in previous studies[7]. One example of this is in relation to consumers' ability to find, evaluate, and compare available products from a wide range of categories[8]. PDEs, particularly the graphics, serve as an important communication tool employed to fulfil consumers' information needs about product qualities[9]. Likewise, Poturak[10] confirmed that PDEs such as colour, printed information, background image, and packaging materials may influence consumers' purchasing behaviour. Tinonetsana[11] determined that structural and verbal packaging elements have a significant effect on consumers' buying behaviour, yet the author argued that the presence of other factors such as time-pressure and level of involvement may also play an important role. Therefore,

when buyers are in a rush, the available visual elements of the product itself become the primary influential factor and vice versa.

Previous research suggests that effects of either textual or visual elements on consumer purchasing decisions are dependent on the type of products being purchased online[12]. For example, textual elements were found to have a greater influence on consumers' decisions than visual elements, especially in food products' purchasing[13,14]. However, Simmonds et al.[8], in their review of the packaging design of food products, contend that visual packaging elements that capture a products' image in the packaging design have an important effect on consumers' buying decisions. Based on these observations, it can be asserted that the varying effects of PDEs on consumers' buying decisions deserve additional research efforts, particularly in the area of e-commerce.

Moreover, several methodological approaches have been used in the literature to explore how various PDEs are linked in a way that effectively optimizes consumers' purchasing decisions. Traditional qualitative methods like focus groups and interviews have proven to be a reliable source of information as they facilitate consumers being engaged in the decisions made during the package creation process. They can help explain the purposeful behaviours of individuals, which include understanding how and why a specific product perception is formed[15], the impact on consumers' purchasing attitudes[16,17], and product choice[18]. However, the use of traditional qualitative methods for acquiring information related to consumers' preferences for one product or another is not without contention. This approach has been criticized as being inefficient, mainly because traditional qualitative methods may lack accuracy as compared to the use of other decision-making techniques when attempting to better ascertain the reasons for a consumers' choice of a particular product on the Web[19]. For example, the use of virtual reality simulation experiments have demonstrated the power of visual imagery in understanding the relationship between customer perceptions about brand

and product quality[20-22] and the purchasing behaviour of consumers[23-25]. In addition, the conjoint analysis approach has also been employed to assess the relative weight of visual and verbal packaging elements and their effect on consumer purchasing decisions[4,13]. Gofman et al.[19] addressed the limitations associated with the use of conjoint analysis in terms of estimating the relative contributions of individual elements to the entire packaging concept.

However, each of the above-mentioned methods are only employed to a limited degree. The current literature contained minimal evidence of the role of these method in determining the level of influence of PDEs on consumer online purchasing decisions. This can be attributed to the lack of statistical power in relation to the consumers own perception of the relative importance of PDEs[19]. Furthermore, previous studies on packaging design may not necessarily provide decision makers and product designers with clear directions on how to connect the various different design elements with consumers' decisions when purchasing online. Based on these observations, the use of a robust decision-making system to account for potential interdependence among different PDEs may help product designers to better ascertain the importance of these elements in the consumers' decision-making process. Current methods may not readily or efficiently address issues related to the interaction between consumers' decisions and certain packaging elements. Therefore, the rationale for this study is to examine the feasibility of using a disciplined decision-making approach that evaluates PDEs in an attempt to determine their level of importance and the weight of their effect on consumers' purchasing decisions in an online marketplace. This generated the following two questions: Firstly, 'What are the key PDEs for online products?', and secondly 'What are the causal relationships between these elements?'. To answer these questions, we studied the feasibility of using multiple-criteria decision making, DEMATEL, to identify and analyse the causal relationships between different PDEs. In addition, DEMATEL is an effective method to study the correlation between consumers reasoning processes and their subsequent influence on the

purchasing decision. It can be used to create an impact-relation map of certain elements, and to ascertain the level of influence of each element over the other[26]. This method not only converts the interdependency relationships into a cause and effect group via matrixes, but also identifies the critical factors of a complex structure system with the help of an impact relation diagram[27]. In the context of this study, the use of the DEMATEL method would help decision makers to more effectively understand the relationship between the design of a package and consumers' decision to purchase products via the internet.

2. Literature Review

Consumers' purchasing decisions have evolved into a discipline that identifies the psychological processes which precede buying behaviours. Consumer buying behaviour refers to the mental, physical and emotional actions an individual carries out during the selection, purchasing, consumption and disposing of goods and services that are done in order to satisfy a need[28]. Kotler et al.[29] proposed a five-staged interrelated model to explain consumer buying behaviour, as follows:

1) The consumer identifies their need or desire to acquire a product
2) The consumer conducts a product search
3) The consumer compares the identified products with other available options and determines which is most appropriate
4) The consumer decides to buy the product
5) The consumer reflects on the advantages and disadvantages of the product post-purchase

Consumers rely on a range of beliefs to form judgements about product quality, which may potentially influence their buying behaviour. According to Steenis et al.[30], consumer purchases are characterized by the cue utilization process (CUP). This process describes how consumers

evaluate products based on cues related to the products' predictive and confidence values. Predictive values are linked to cues associated with benefits, whereas confidence values are related to the accuracy of the judgement based on the available cues. The CUP points to intrinsic and extrinsic judgement cues about a product, and since intrinsic cues are not easily accessible, consumers often rely on product packaging as an extrinsic cue in the purchasing environment [21,30].

Product packaging has evolved from simply covering and protecting a product[14] into a science that seeks ways to capture consumers' cognitive, emotional and physical attention. Recent studies have specifically focused on the role of certain packaging elements in stimulating consumers' decisions to buy a product. Packaging is integral to the 'Four Ps' in the 'marketing mix' concept and is a promotional tool for products and brands alike[31]. Packaging consist of both structural (e.g. packaging material, shape, size, weight and texture, and graphic features) and verbal design features that are placed on the product (such as textural information)[4,11,18,30,32]. Silayoi et al.[18] stated that *"packaging represents the salesman on the shelf"*. In addition, Clement[23] describes product packaging as a means of attracting consumers' attention to the brand or the product. According to Silayoi et al.[4], packaging is critical to consumers' subjective perception of a product, which may significantly alter their buying decision. It is the most effective technique for consumers who make buying decisions instantly.

The literature categorises product packaging elements into two categories of visual, and verbal, packaging elements. The first category consists of the elements of a product, which have the potential to capture consumers' attention and increase the probability of a purchase in the future. Examples of visual elements include graphics, colour, packaging technology, shape, and size. The second category consists of elements that supposedly offer further details about a product to consumers. Examples of verbal elements include nutritional information, label information, country of origin, and brand name. The cause and effect relationship between

these elements is examined in this study. The next section explores the role of these elements in the purchasing environment.

2.1 Graphics

Product graphics typically consist of the general layout, colour combination, typography, and product photography[4]. The characteristics of a packages' graphical design has the potential to appeal to the consumer's aesthetic sense and arouse their interest in a product, in addition to increasing the probability of a purchase[33]. Graphics provide a simpler means for an individual to evaluate product alternatives, especially for low-involvement customers[18]. Using high-quality graphics can potentially attract the attention of consumers[20], communicate an image of quality to consumers[34], and generate a significant amount of impulse buying behaviours from consumers[9].

2.2 Colours

Colour is a critical element of product packaging. It creates moods, draws consumers' attention to a product, and highlights its quality. Keller[35] reported that colour is an important visual variable for product packaging and offers a certain degree of uniqueness to the product brand. Thus, the choice of colour in product packaging can potentially lead to a good impression among consumers[19]. In addition, colour enhances consumers' level of recognition by making it easier to distinguish one product from others[10]. Colour has been used to communicate feminism or masculinity, as well as the quality and durability of products.

2.3 Shape and size

Designing attractive products requires a proper shape and size so as to positively influence consumers' attention. For instance, consumers, in general, perceive elongated

packages to be larger which may affect and inform their decisions about product quantity[18]. Whilst package shape and size often conveys a subjective impression, studies suggest that consumers are always drawn to products by these elements[4]. Agariya et al.[31] found that consumers' preferences for a product shape or size are based on their unique needs and purchasing power. Thus, smaller product packaging designs have the potential to attract a new target market.

2.4 Packaging material

Packaging material is another essential component of the customer decision-making process as it communicates information about the product quality. Although the general belief amongst consumers is that packaging material helps protect the product from damage[10], the available research evidence suggests that packaging materials are the most preferred by consumers[16]. Recently, the discourse on packaging materials has shifted towards environmental sustainability and the preservation of natural resources[31,36]. Consequently, consumers are gradually becoming increasingly aware of their role in environmental sustainability. This was confirmed by Steenis et al.[30], as they found that consumers are often attracted to packaging materials, particularly those that have an environmentally friendly or conscious quality. In the long term, this may change consumers' preferences toward the packaging material, and thus their preferences toward the product.

2.5 Packaging technology

The drive for enhanced individual satisfaction has led to innovative packaging strategies that are beneficial to both customers and producers[28]. According to Silayoi et al.[18], consumers are willing to pay more for products with enhanced packaging features. Therefore, technology embodied in product packaging can help to inform about consumers' perceptions

of product quality, shelf-life, sustainability, and safety. Silayoi et al.[4] reported that packaging technology can significantly influence consumers' buying behaviours. It is assumed that when product features are relevant to consumer preferences, they will be able to make their purchasing decision more quickly. This is supported by Wyrwa et al.[14], who stated that consumers generally prefer packaging technology that provides comfort of use and durability.

2.6 Nutritional information

Nutritional information is particularly relevant to consumers' purchasing decisions with regards to food products. Adam et al.[5] and Freire el al.[37] found that nutritional information displayed on packaging has a very important role here. This is because consumers have become more health conscious and are now gravitating towards the nutritional values displayed on the product package[32], especially in terms of natural and organic products. In their study, they found that the implicit message communicated by structural packaging elements differs between health-positioned and regular products. Therefore, a selection of appropriate designs is important. However, Epperson et al.[15] pointed out the dangers associated with the trend of the preference for organic and natural products. In their study, they found that 'organic' and 'natural' labels may deceive consumers into thinking that products that have previously been established as risky to health suddenly become less risky and the best out of the other alternatives. This may potentially influence consumers' perceptions towards a product or brand.

2.7 Label information

Label information serves as a verbal communication element that helps to convey information about a product to consumers[17,28]. It involves cognitive processes (conveys information) which may influence individual emotions (affective) and actions (behavioural).

Information can be grouped into semantic and non-semantic. Semantic information includes the presence of legible information about the product name, purpose, and usage warnings. In contrast, non-semantic information consists of a suitable colour combination for easy reading, an appropriate font style, and warning colours[14]. Furthermore, non-semantic information has the potential to create confusion for consumers, since label information can either reveal too little or too much information, or can contain inaccurate information, which is misleading[18].

2.8 Country of origin

Consumers are typically aware of countries who have succeeded in creating an image of quality and success regarding the manufacture of certain products. Adam et al.[5] found that consumers are particular about the origin of products and it can have a substantial influence on their decision to purchase. According to Wyrwa et al.[14], the increasing awareness about the relationship between health and products has caused consumers to consider a products' origin and decision to purchase. Ribeiro et al.[17] found that the country of origin displayed on product packaging may help to increase the level of consumers' attention given to it, thus influencing their decision to purchase a product.

2.9 Brand name

A brand name helps stimulate consumers' memory and separates a product from others. It refers to symbolism, words, or names that are legally registered as a trademark and used by producers to characterize their products[20,28]. The literature review revealed that having brand names placed on packages is critical for conveying a positive image to consumers[38]. In addition, a brand name generates many other associations in the mind of consumers, as well as other advantages to ensure the uniqueness of the product and attract loyal customers. Strong brands are essential for corporate image[28], which shapes the way a consumer perceives a

product[38]. Agariya et al.[31] addressed the main issues related to brand name, such as 'caveat emptor', and their role in increasing consumers' willingness to purchase products. Brands are posited to induce hedonic benefits for consumers.

3. Interactions Between Various PDEs

The literature review uncovered studies that investigated possible interactions between various PDEs and consumer purchasing decisions in an online marketspace. Studying these interactions is fundamental to understanding consumers' information processing and purchasing decisions. For example, Klink[39] reported a relationship between specific structural characteristics of the brand name and the brand marks' size, shape, and colour. From the consumers' perspective, brands with marks that are consistent in design with the brand name can offer a better representation of the brand meaning. Bottomley et al.[40] studied the notion of congruity in relation to product design and brand. They found that it is more effective for functional products to be presented in functional colours, and sensory social products in sensory-social colours. They asserted that this enabled consumers to know how brands are attempting to position themselves.

Clement[23] used an eye-tracking tool to describe the relationship between consumers' buying behaviour and the design of a product. He found that individuals' visual attention being drawn may potentially result in increased visual activity. For this reason, it can be assumed that product packaging has the potential to draw consumers' visual attention, and potentially influence their purchase decisions. In the study conducted by Cahyorini et al.[9], graphics stood out among the other PDEs as generating the most attention from consumers. Also, Raheem et al.[41] examined the role of packaging in increasing consumers' positive purchasing decisions. Their findings reiterate the importance of colour in attracting customers' attention, thus affecting their decision to purchase a product or not. In general, colour can shape consumer

perceptions of areas such as brand personality, familiarity, and likability, and thereby impact their purchase intent[25,42]. This was emphasized by Epperson et al.[15] who found that consumers were often attracted to products that have unique, bright and eye-catching colours. Ribeiro et al.[17] found that most consumers prefer glass packaged products to plastic ones. This is due to the assumption that glass adds quality to the product and is more friendly to the environment than plastic. Therefore, products in glass packaging have the potential to attract more attention from consumers as well as increase the likelihood of a purchase. The literature review showed a direct relationship between shape, size, and customer needs (e.g., Hollywood et al.[16]; Ribeiro et al.[17]).

The literature appears consistent in pointing out the overriding effect of visual PDEs on consumer purchasing behaviour over the verbal PDEs. Orquin et al.[43] explained that consumers can be attracted to the visual environment as a result of their interaction with the visual elements of a product. However, there are some instances where verbal PDEs may appear to influence consumers' decision over visual PDEs. Heide et al.[13] and Wyrwa et al.[14] concluded that consumers were primarily attracted to nutritional information displayed on food products, rather than the visual PDEs. Yet, Simmonds and Spence[8] reported that certain visual PDEs on food products may have greater potential to attract consumers to a product than verbal PDEs. Moreover, Mundel et al.[21] determined that consumers are drawn to products through verbal PDEs such as the brand. It is possible that certain emotional and self-concept cues are more associated with the brand image and its quality. This finding about the communicative power of the brand is in contrast with an earlier study conducted by Hollywood et al.[16], who reported that brand names do not necessarily influence the purchasing decision of consumers, especially when they are more concerned with product substance. Despite this, there is little evidence about how the brand name is associated with other products' features.

Based on these observations, the inconsistent interaction effects of verbal PDEs on consumer purchasing behaviour requires further research, particularly in the context of an online marketplace. This will lead to a greater awareness of product packaging strategies as a means to capture consumers' attention and to provide heuristic guidance for purchasing decisions. Using these findings as a framework, this study attempts to construct a DEMATEL model to identify the key packaging design elements (PDEs) and the causal relationship between them. More details about the role of DEMATEL approach in this study is provided in the following section.

4. Method

The DEMATEL approach was first introduced by the Geneva Battelle Institute in 1971 in an attempt to study complex decision-making and reasoning processes related to many situations, such as organisational policies and rules, marketing strategies, and control systems. It is constructed based on the concept of graph theory to create visualized structural approaches. This includes presenting a cause-effect diagram and directed graph to illustrate cause and effect and interdependent relationships between a set of predetermined factors. Recently, the DEMATEL method has been used by many scientists in order to investigate or explore problematic decision making and industrial planning. In the multi-criteria decision-making field, the DEMATEL model is generally produced to visualize the interrelations between the various criteria. In order to generate a valid impact-relationship map, it is necessary to identify the relevant threshold value that can be employed for further analysis and decision making. Here, the DEMATEL method is used to determine the causal factors of PDEs and the causal effects of these factors on consumers' decisions to purchase products online.

4.1 Participants

A total of 142 students (89 males and 53 females, aged 22–37) were recruited from a public university to participate in this study. In order to ensure that the participants had the required level of knowledge and skills, we selected those who had 5 to 8 years of online purchasing experience, and were familiar with different local and global e-commerce sites. For example, the participants had to be frequently engaged in online purchase activities using various e-commerce channels. These measures were taken primarily to ensure that all participants have an implicit perception and understanding of PDEs, as well as the ability to perceptually notice the difference between them. The major activities the participants identified as common in e-commerce platforms were products listing, searching, browsing, comparing, and buying.

4.2 Procedure

Prior to data collection, a screen projector in the computer lab was used to help the participants by clarifying some essential points for answering the PDEs questionnaire. This session was essential to minimize self-doubt about the types of each PDE among the participants. All of the participants were encouraged to ask questions about these PDEs in relation to their daily use. E-commerce websites were frequently utilised to make the item-description process clearer to the participants during the interview session, along with providing vital examples and vivid descriptions about the design elements whenever required. Once the interview dates were set, the interview questions were mailed to the 142 participants involved in the study. Because the interview questions were closed-ended, the participants were able to identify the strength of the influence between PDEs on their purchase decision for a product. All the participants were asked to respond to multi-scale questions (0 = No influence; 1 = Very low influence; 2 = Low influence; 3 = High influence; and 4 = Very high influence)

related to the relationships between PDEs (e.g., the influence of package design elements (Graphics and Colours) on your decision to purchase a product). The participants were guided to estimate the level of effect of each crossover between the predefined PDEs (see Table 1). Once the responses were collected, they were coded using the MATLAB file code for DEMATEL modelling.

[INSERT TABLE 1 HERE]

4.3 The DEMATEL Model

In order to apply the DEMATEL method, firstly, the average matrix for all the PDEs was computed (see Table 2). Secondly, the normalized initial direct-relation matrix, the total relation matrix, the threshold value, and the production of the causal diagram were calculated.

[INSERT TABLE 2 HERE]

4.3.1 Compute the average matrix

Each participant was asked to provide their opinions regarding the direct influence of one factor on another using integer scores (0, 1, 2, 3, and 4) that represent 'no influence', very low influence', 'low influence', 'high influence' and 'very high influence' respectively. The notation of x_{ij} was used to refer to the degree to which participants believe factor *i* may affects factor *j*. For $i = j$, the diagonal values were set to zero. For each participant, a $n \times n$ non-negative matrix was constructed as $x^k = [\, x_{ij}^k]$, where k is the number of participants with $1 \leq k \leq H$, and n is the number of PDEs. To incorporate all opinions from H participants, the average matrix $A = [a_{ij}]$ was constructed as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{n1} & \ldots & a_{nj} & \cdots & a_{nn} \end{bmatrix} \quad 1$$

$$A = [a_{ij}] = \frac{1}{H}\sum_{k=1}^{H} x_{ij}^{k} \quad 2$$

The finalized averaged direct-relation matrix was constructed (see Table 3). Based on the averaged relation matrix, these numbers were normalized continuously to produce the initial direct-relation matrix presented in the following subsection.

[INSERT TABLE 3 HERE]

4.3.2 Calculating the normalized initial direct-relation matrix

After obtaining the initial direct-relation matrix, it was further normalized using equations (3) and (4), where *Z* presents the initial normalized direct-influence matrix. Each element in matrix *Z* falls between zero and one.

$$Z = m \times A, \quad 3$$

$$where\ \ m = \min\left[\frac{1}{Max_i \sum_{i=1}^{n} a_{ij}}, \frac{1}{Max_j \sum_{j=1}^{n} a_{ij}}\right], i, j\ \in \{1, 2, \ldots, n\} \quad 4$$

[INSERT TABLE 4 HERE]

4.3.3 Calculating the total relation matrix

The total-influence matrix *T* was obtained using equations (5) and (6), in which *I* was used to represent the identity of the matrix. The element t_{ij} represents the indirect effects that factor *i* had on factor *j*, and the matrix *T* reflects the total relationship between each pair of the PDEs.

$$T = \lim_{m\to\infty}(Z^1 + Z^2 + .. + Z^m) \quad (5)$$
$$= \sum_{m=1}^{\infty} Z^m$$

where

$$\sum_{m=1}^{\infty} Z^m = Z^1 + Z^2 + .. + Z^m$$
$$= Z(I + Z^1 + Z^2 + .. + Z^{m-1})$$
$$= Z(I - Z)^{-1}(I - Z)(I + Z^1 + Z^2 + .. + Z^{m-1})$$
$$= Z(I - Z)^{-1}(I - Z)^m$$

$$T = Z(I - Z)^{-1} \quad (6)$$

4.3.4 Setting up the threshold value (α) and obtaining the causal-relation map

The total relation matrix *T* illustrates how one factor affects another. In any decision-making process, it is necessary to establish a threshold value in order to reduce some negligible effects. In this study, the threshold value was determined by adding the mean (0.44) and the standard deviation (0.08) of the elements in total matrix *T*, $\boldsymbol{\alpha} = 0.52$. Table 5 shows the total relation matrix *T* for this study.

[INSERT TABLE 5 HERE]

4.3.5 Producing the causal diagram

To draw the causal relation-map, the sum of the rows and the sum of the columns were separately produced as vector R and vector C using equations (7) and (8). The horizontal axis vector (R + C), named 'Prominence', represents the importance of the criterion. Similarly, the vertical axis (R - C), named 'Relation', divides criteria into a causal group and an effect group. A factor was placed under the causal group if the value of (R - C) was positive, and under the effect group when the value of (R - C) was negative. Based on this, the causal diagram was generated by mapping the dataset of (R + C, R - C).

$$\mathrm{R} = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \quad (7)$$

$$\mathrm{C} = [c_i]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \quad (8)$$

[INSERT TABLE 6 HERE]

[INSERT FIGURE 1 HERE]

Figure 1 shows the causal relation diagram based on the most important (prominent) elements of packaging design and the most significant relationships amongst the PDEs in terms of persuading consumers to make the decision to purchase online. The four most important PDEs were found to be: graphics (F1), colours (F2), label information (F7), and country of origin (F8), with the values of 18.45, 18.42, 16.73, and 15.88, respectively. Interestingly, nutritional information (F6) was the least important criteria, with a value of 15.85. Contrary to the importance of criteria, graphics (F1) and colours (F2) were net causers, whereas brand name (F9), shape and size (F3), and packaging material (F4) were net receivers in accordance with the value of difference (r−c, shown in Table 6).

5. Results and Discussion

The process followed in designing a product package or interface must ensure the combination of the products' attributes and the overall impression through certain design elements. However, which packaging elements can trigger consumers' decision buying process remains unknown[23]. This study created a DEMATEL model for identifying the core packaging design factors and the cause-and-effect relationships between them in an e-commerce platform. The overall results show the potential impact of certain PDEs on consumers' decisions to purchase a product via the internet. Several associations between PDEs were identified through this study. The results show that graphics, colours, label information, and country of origin

were the most important PDEs. Having graphics and colours as the most prominent factors was the expected result (as shown in Figure 1). In addition, nutritional information was the least important criteria.

The impact of graphics on the purchase decisions of online consumers was the highest influential factor. According to Clement[23], consumers' visual attention is raised as the visual stimuli is increased. This may imply that the logo and/or graphic symbols are an important element for forming consumer perceptions of a product, and consequently, defining its positioning in consumers' minds[44]. It also supports previous findings, such as Kuvykaite et al.[45] and Cahyorini et al.[9], about the role of graphics in shaping consumers' decisions to buy products. Their research also addressed how the impact of graphics may vary from one product category to another. A cause-and-effect relationship was determined between graphics and colours, which can be attributed to the fact that the graphical structure depends largely on colours and colour dynamics. This is supported by Rundh[46], who argued that the main effects of graphics on consumer perception can involve the use of a suitable colour and thereby reinforce the brand name or image of the product. The relationship between graphics and the shape and size of the package was discovered to influence the consumers' decision process. In a study on consumer product packaging, graphics and the shape of a product were found to create the necessary category cues since they influence sensory appeal and the visual appearance of the packaging. This shows that consumer have a clear understanding of the role of graphics on their decision to buy a particular product. Therefore, ensuring a proper placement of graphics, together with a supportive shape and size, are highly useful for consumers' decision-making[47]. A study conducted by Lo et al.[48] supports this, as they concluded that colour, graphics, and shape of packaging affect the decision-making process of consumers prior to purchasing products.

Today, the way of structuring and producing products' packaging attributes is highly prioritised, because the design of packaging materials is one method of creating and protecting the brand and reputation of the organization[49]. The use of graphics and its relation to packaging materials was found to influence consumers' decision to purchase online products. This can be linked to the quality of product structure and environmental impact. For example, some consumers are more concerned about maximizing product quality, safety, and shelf-life, while minimizing undesirable changes in product materials. In addition, packaging materials contribute to many environmental issues that are typically linked to the consumption of resources and energy, and the resultant waste stream at end-of-life-cycle. This finding supports the work of Wikström et al.[50] who stressed the need to consider the design of packaging materials and formats to reduce their environmental impacts.

The results also show a clear relationship between colour choices and brand name in influencing the consumers' decision process to buy online. In general, the choice of colours has always been found to enhance the visual quality of the product through facilitating perceptual cognition/recognition and embodied interaction in users[51]. In an ecommerce platform, colours and brand name are the two attributes that consumers can evaluate without sampling a product[52]. This finding is in line with several previous studies, such as that by Piñero et al.[53], which highlighted the role of brand name and colours in shaping the purchase decisions of a product. The relationship between colours and the shape and size of a product was also found to have a certain degree of impact on consumer's decision to purchase a product. According to Mugge et al.[54], both colour and shape can be used to manipulate the novelty in product appearance. In addition, the association between colour choice and the shape of the product can be manipulated to convey or modify a specific brand image. For example choosing round shapes and warm colours contributes to conveying messages of sophistication and femininity[55]. This is supported by Brakus et al. [5'6] who addressed the importance of using

unique colours and shapes. They asserted that consumers' preferences for colours and shape may very prominently help them to differentiate products.

In conclusion, the relationship between colours and packaging materials and its impact on consumers' decision to purchase from the Web were identified in this study. The choice of colours for designing a package play a vital role in facilitating consumers interaction and their understanding of the product[57]. It is possible that there is a strong correlation between designers' choice of colours to improve the appearance of the product and the types of materials used. Today many consumers purchase online products based on their attractiveness, and in turn use those judgments as the basis for assessing the persuasiveness of the product and placement message[58]. Thus, effective design strategies of online products require more consideration of the various design aspects that may potentially shape consumers' decision to purchase them. Interestingly, the low influence of nutritional information on the decision-making process of consumers was not expected. It is assumed that nutritional information may not be relevant to those who do not consider themselves ill or elderly, or for products which are not consumed directly into/on the human body. In addition, consumers may not formulate or carry out strategies to change their patterns of purchase and consumption of dietary products because they value established preferences and feel that individual acts of consumption will not affect their health[37]. This finding is in line with many previous studies (e.g. [59-61]) which have shown that nutritional information is not the sole influence on individuals' choices or intentions to purchase a product. However, it remains necessary to investigate the reasons behind this low impact on consumers' decisions in an e-commerce platform.

6. Implications and Limitations

The application of the DEMATEL method for identifying PDEs has shown great potential, which can be integrated into the design workflow of online products. The

DEMATEL map of PDEs can be used by product designers, product development managers, and researchers to understand how certain PDEs may influence consumers' decision to purchase online. The association between PDEs can help both firms and policy makers to better understand consumer behaviour and to enhance the interaction between customers and products. For example, product designers may put more emphasis on label information, colours, graphics, and country of origin when designing a product package. This can help consumers to make more informed dietary choices. We also think that the choice of these PDEs can ultimately alter consumers' behaviour and purchasing decisions on the Web. For example, when users of e-commerce websites are able to view and understand a product's quality, they are more likely to be able to build connections between the relevance of product and their decision to purchase it. Despite these implications, this study imposes some specific limitations that need to be addressed in the future. For instance, the use of certain PDEs was for non-food products, whereas other design elements associated with other product types may potentially result in different causal relationships. Furthermore, the consideration of certain packaging design combinations and their effect on consumers' behavioural aspects such as satisfaction, intentions, and attitude can be further investigated. Future works may also consider examining other packaging design characteristics based on the different types of online products.

7. Conclusion

This study examined the feasibility of using the DEMATEL approach in modelling the key PDEs for online products and the causal relationships between them. PDEs related to country of origin, graphics, label information, and colours were determined to be the core elements that stimulate consumers' decisions to purchase products via the internet. Observation of PDEs interaction implied that there is a significant relationship between:

- graphics and colours

- colours and packaging materials
- colours,
- shape and size

This study found that consumers' perceptions or behaviours can be influenced by the cause-and-effect relationship of PDEs, thus driving their purchase decision from the Web. Furthermore, this study provides the necessary insights into the design of product packaging by targeting aspects related to the appearance of products' characteristics. The association between different PDEs obtained from this study can be employed to increase consumers' interactions with products in e-commerce environments.

Acknowledgement

The authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding this work through research group No (RG-1438-062).

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Biography

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TABLES

Cause-effect matrix	Graphics	Colours	Shape & size	Packaging material	Packaging technology	Nutritional information	Label information	Country of origin	Brand name
Graphics									
Colours									
Shape and size									
Packaging material									
Packaging Technology									
Nutritional information									
Label information									
Country of origin									
Brand name									

Instructions for filling out the index: 0 = No influence; 1 = Very low influence; 2 = Low influence; 3 = High influence, 4 = Very high influence.

Table 1. The cause-and-effect matrix

PDEs	Description
F1	Graphics
F2	Colours
F3	Shape and size
F4	Packaging material
F5	Packaging Technology
F6	Nutritional information
F7	Label information
F8	Country of origin
F9	Brand name

Table 2. PDEs coding

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	0.00	3.09	3.06	3.09	2.71	2.57	2.74	2.34	3.09
F2	3.09	0.00	3.09	3.14	2.69	2.37	2.54	2.03	2.97
F3	2.80	2.97	0.00	2.86	2.31	2.20	2.37	2.03	2.77
F4	2.69	2.91	2.89	0.00	2.46	2.23	2.37	2.17	2.57
F5	2.46	2.60	2.46	2.37	0.00	2.29	2.26	2.17	2.60
F6	2.31	2.26	2.23	2.29	2.06	0.00	2.31	2.31	2.49
F7	2.69	2.66	2.57	2.57	2.23	2.43	0.00	2.17	2.69
F8	2.54	2.60	2.43	2.31	2.31	2.40	2.31	0.00	2.54
F9	2.63	2.74	2.57	2.51	2.43	2.43	2.46	2.54	0.00

Table 3. The averaged relation matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	0.00	0.14	0.13	0.14	0.12	0.11	0.12	0.10	0.14
F2	0.14	0.00	0.14	0.14	0.12	0.10	0.11	0.09	0.13
F3	0.12	0.13	0.00	0.13	0.10	0.10	0.10	0.09	0.12
F4	0.12	0.13	0.13	0.00	0.11	0.10	0.10	0.10	0.11
F5	0.11	0.11	0.11	0.10	0.00	0.10	0.10	0.10	0.11
F6	0.10	0.10	0.10	0.10	0.09	0.00	0.10	0.10	0.11
F7	0.12	0.12	0.11	0.11	0.10	0.11	0.00	0.10	0.12
F8	0.11	0.11	0.11	0.10	0.10	0.11	0.10	0.00	0.11

Table 4. The normalized initial direct-relation matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9
F1	1.00	1.14	1.12	1.12	1.02	1.00	1.03	0.94	1.14
F2	1.09	0.99	1.09	1.09	0.99	0.97	0.99	0.91	1.10
F3	1.02	1.05	0.91	1.02	0.92	0.90	0.93	0.85	1.03
F4	1.01	1.04	1.02	0.90	0.92	0.90	0.93	0.85	1.02
F5	0.96	0.98	0.96	0.95	0.78	0.86	0.88	0.82	0.98
F6	0.91	0.93	0.91	0.91	0.83	0.74	0.85	0.79	0.93
F7	1.00	1.02	1.00	0.99	0.90	0.90	0.82	0.84	1.02
F8	0.97	0.99	0.97	0.96	0.89	0.88	0.89	0.74	0.99
F9	1.01	1.03	1.01	1.00	0.92	0.91	0.93	0.87	0.92

Table 5. The total relation matrix T

Factors	Code	R	C	R + C	R - C	Impact
Graphics	F1	9.50	8.95	18.45	0.55	Cause
Colours	F2	9.23	9.19	18.42	0.04	Cause
Shape and size	F3	8.63	8.99	17.62	-0.36	Effect
Packaging material	F4	8.61	8.94	17.55	-0.33	Effect
Packaging technology	F5	8.17	8.18	16.35	-0.01	Effect
Nutritional information	F6	7.80	8.05	15.85	-0.25	Effect
Label information	F7	8.49	8.24	16.73	0.25	Cause
Country of origin	F8	8.27	7.61	15.88	0.66	Cause
Brand name	F9	8.60	9.14	17.74	-0.54	Effect

Table 6. Impact relationship

FIGURES

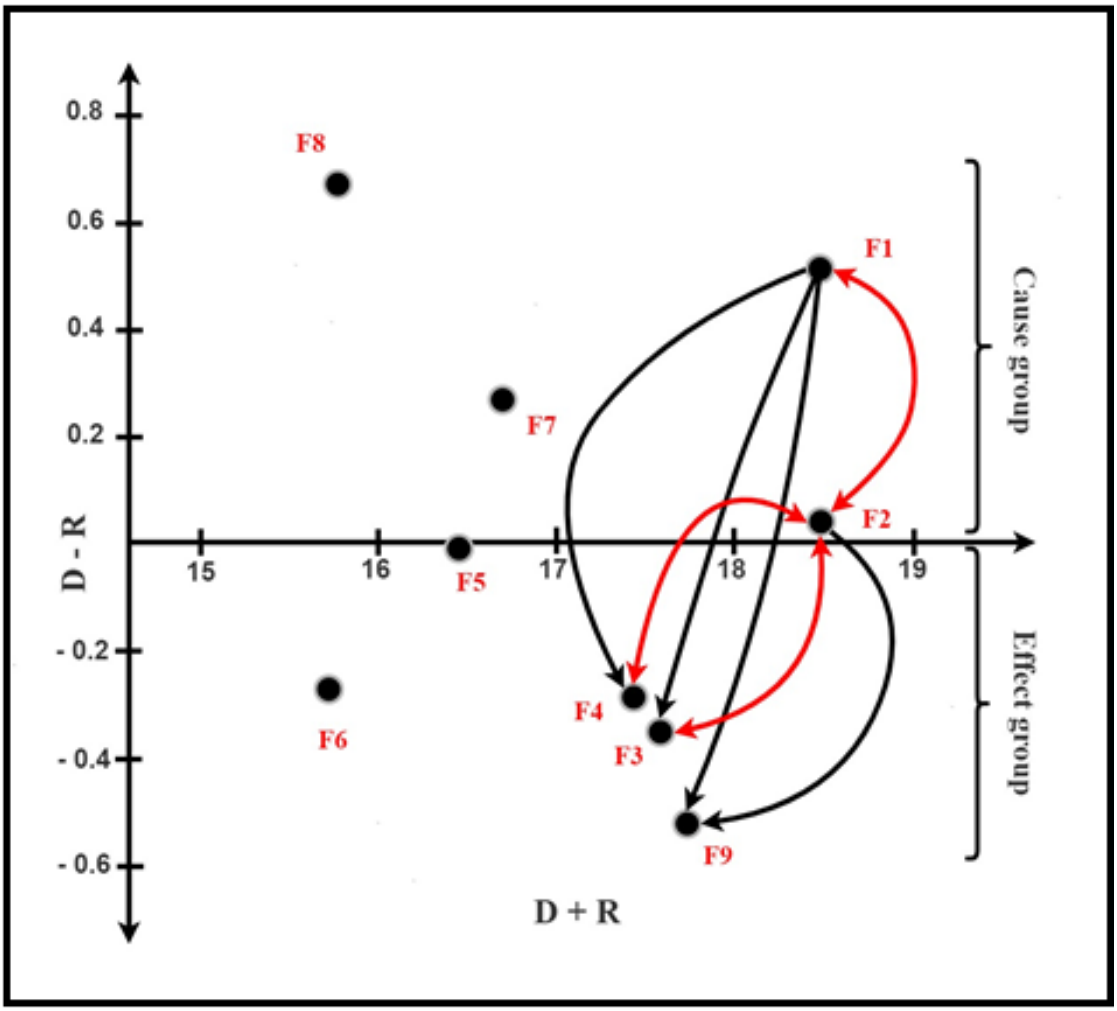

Figure 1. Causal relation diagram of the study